Moseley's law :-

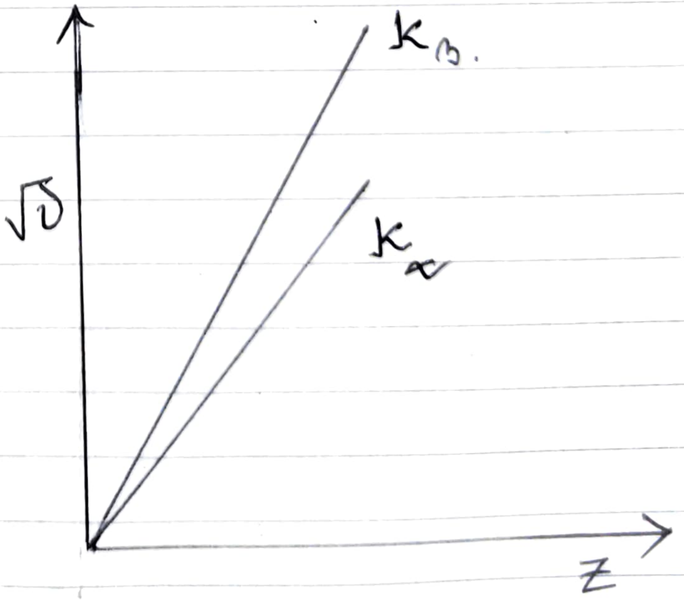
In 1914, Moseley made a detailed & systematic study of the characteristics X-ray spectra of different element – light as well as heavy. From his investigations he conclude that –

The freq of a spectral line in X-ray spectrum, varies as the square of the atomic number of the element emitting it. i.e $\nu \propto Z^2$. This is known as Moseley's law.

Based on the experimental data, ~~Mathematically~~ Moseley's law may be represented as ~~follows~~

$$\sqrt{\nu} = a(Z-b)$$

where a, b are consts ~~characteristic of the element~~ depending upon the particular line.



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Derivation of Moseley's law from Bohr's theory :-

The general form of Moseley's law can be easily derived from Bohr's theory.

Let a transition occur from n_2 state to n_1 state. Thus, according to Bohr's theory the freq of the emitted X-ray photon is

$$\nu = Z^2 Rc \left(\frac{1}{n_1^2} - \frac{1}{n_2^2} \right)$$

$$= a^2 Z^2 \rightarrow (1) \quad \text{where } R \text{ is} \ldots, \; c \text{ is} \ldots$$

$$\therefore \sqrt{\nu} = aZ \quad \text{where } a^2 = Rc\left(\frac{1}{n_1^2} - \frac{1}{n_2^2}\right)$$

is a const.

For K_α line, $n_1 = 1$ & $n_2 = 2$

$$\therefore a^2 = \frac{3}{4} Rc$$

The presence of the const b in Moseley's law eqn, as deduced from the experimental data, has been interpreted as the "shielding effect of nucleus" by the remaining electrons in the lower level & b is known as the screening const.

For eg, for K_α emission, one of the two K-electrons is first

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emitted leaving a single e^- in K-shell. The -ve charge of this residual e^- partially screen the nuclear charge +Ze of the atom. The effective Coulomb force on the L-electron is thus due approx. to a net +ve charge +(Z-1)e. So, instead of Z^2 in equⁿ ① we should rather write $(Z-1)^2$. Under such circumstances, equⁿ ① becomes.

$$\nu = a^2 (Z-1)^2$$

where $a^2 = \frac{3}{4} RC$ and $b = 1$.

With this interpretation, we have the Moseley's law in the form.

$$\sqrt{\nu} = a(Z-b).$$

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